Working paper

2015-15

MACROECONOMIC POLICY AND POTENTIAL GROWTH

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May 2015

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May 26, 2015

Abstract

We make the case for investigating the gap between the potential and the actual level of production, and review contributions that point to the reduced power of standard policy instruments in presence of a prolonged gap. We also highlight difficulties in measuring where an economy stands relative to its potential. We review links between human capital accumulation and technology, and sketch a basic Schumpeterian model that puts at the center stage of the growth process investments in innovation and the foundation of new firms, arguably two key sources of growth that could revitalize the faltering European Economies. The gap between the short and long run behavior is illustrated through quantitative experiments.

1 Introduction

The relationship between potential growth and output gap has been recently debated with great intensity both in academic and policy circles. Recently, Alvin Hansen's hypothesis of "secular stagnation" in advanced countries has been revived by Larry Summers and by Robert Gordon who have identified a number of weaknesses on the demand side and the supply side of the economy, respectively.[1] On the one hand, a savings glut puts downward pressure on the interest rate, making the yield on future capital rather low and therefore limiting future demand. On the other hand, the recent wave of innovations would not compete with electricity, indoor plumbing and internal combustion in terms of producing a surge in productivity and in standards of living; coupled with population ageing, rising inequality, educational mismatch and high public debt ratios (Gordon's four headwinds), lack of strong technical progress in the future would lead to future low economic growth. Although potential growth is not strictly similar to future economic growth, for they can apply to different horizons (the mid-run for the former and the long-run for the latter), the revival

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[1] Their most recent contributions can be found in a Voxeu ebook edited by Teulings and Baldwin (2014).

of economic thinking about "secular stagnation" cannot be entirely absent from the reflection on the determinants of potential growth.

In the European Union (EU), new fiscal rules embedded in the Fiscal compact and the revision of the Stability and Growth Pact introduced targets on public spending and cyclically-adjusted deficits; by definition, they require a precise assessment of the gap between actual and potential Gross Domestic Product (GDP), i.e. the output gap. For instance, if the output gap is close to zero in an EU member state, the whole public deficit that remains in this country is a structural one; if it exceeds the limit of 0.5% of GDP, the Fiscal compact requires that the country actively endeavors to reduce public spending and/or raise taxes. Quite automatically, it appears that the output gap can be made instrumental to the choice of the optimal fiscal strategy, a very important debate in the EU and the Eurozone.

We believe that there are at least three reasons why the concept of potential growth is important. First, as it emerges from these debates, potential growth gives an overview of the long-run growth of the supply side of the economy, and thus gives an outlook of the future strengths or weaknesses of an economy and requires studying the different constraints placed on future supply.

Second, the difference between the actual output and the future output gives information on the economy in the short run. If actual output is below its potential level, the economy runs with over- capacities and can be expected to grow faster, unless the demand side remains weak. An analogy with the situation of the Euro area after the global financial crisis can be made: although actual GDP has remained below its potential in Europe since 2009 according to OECD estimates, actual economic growth has not resumed. This may have been caused by the constraints on supply in the short run and/or by the use of economic policies, which is the third reason for interest in the concept of potential growth.

Monetary policy is usually supposed to react to the gap between actual GDP and potential GDP, according to the famous Taylor (1993) rule, while fiscal policy does as well, under the heading of "automatic stabilizers". If actual GDP is below its potential, the nominal interest rate is set at a lower level by the central bank, while current spending and tax receipts are given some leeway to grow, for the former, and to decrease, for the latter, hence producing a rise in the public deficit. Going back to the analogy above, once the nominal interest rate has hit its lower bound, the economy can be stuck in a so-called "liquidity-trap" that makes it impossible to boost demand and make it converge towards future potential output. As for fiscal policy, it can be made inefficient if, prior to a crisis on demand, automatic stabilizers have not been sufficiently developed, or if they have been sacrificed to reduce the size of governments via lower spending, including social ones, and lower tax rates (Creel and Saraceno, 2010).

The list of factors that the literature has proposed as key determinants for long run growth is long; yet there is a consensus that the real challenge is setting up the right incentives for investments and in understanding the correct balance across different types of investments. Here with investments we mean not only resources devoted to the accumulation of physical capital, but also to human capital as well as to technology. In fact, a view, which goes as far back as Arrow (1966), sees investment and the adoption of new technology as being two sides of the same coin.

The need to coordinate investments in human capital and technology was made sometimes ago by Goldin and Katz in their book "The Race between Education and Technology". Their empirical work is based on the US economic time-series, but their arguments are fairly general. Their first point is just a reassessment of what many others, chief among them Gary Becker, had found earlier: Human capital is a central determinant of economic growth. But they also document how investments in human capital played a major equalizing role in the US. Therefore, a slowdown in the accumulation of human capital, as it has been observed in some Euro countries, could have a negative effect on wage inequality. In fact, the most compelling observation of their work, which bears a lot of relevance for the future of growth in Europe, is the erosion of the forces that had fueled the rapid growth of education in the US. Conversely, following a tradition initiated by Tinbergen, they claim that technology tends to be skill-biased. Therefore, moments of rapid technological progress tend to widen inequality among skill groups unless it is countered by increases in the supply of human capital.

Although increasing the supply and quality of human capital is a way of ensuring more rapid and more equitable growth, a potential trade-off between inequality and growth remains if human capital accumulation is matched with new technologies. Specifically, if new technologies replace tasks previously performed by middle skilled workers and are also expanding the set of tasks that high skill workers can perform, policy makers should be paying more attention to the top of the human capital distribution. Acemoglu and Autor (2002) use this observation to lend support to 'elitism' of educational institutions.

A related question is how education can promote the creation, accumulation and diffusion of knowledge across individuals along the dimensions of space and time. Workers benefit from being in a dense, skilled, labor market. Productivity-enhancing external benefits of labor markets are often called human capital externalities, knowledge spillover effects, learning externalities, or labor market local agglomeration economies. Uncompensated externalities from aggregate human capital stock have long been considered one of the important forces of economic growth (Romer (1986), Lucas (1988)). Further, local human capital externalities are considered to be one of the predominant reasons for the existence of cities and urban endogenous growth.

In particular, one class of growth theories (Romer (1986), Lucas (1988, 2004), Tamura (1991), Parente and Prescott (1994), Peretto (1998)), features externalities in the accumulation of knowledge possessed by firms or by workers. Another class of growth models (Rivera-Batiz and Romer (1991) Romer (1994) Kortum (1997)) features externalities from the introduction of new goods, in the form of surplus to consumers, to firms or to both. Other theories combine knowledge externalities and new good externalities ((Stokey (1988, 1991) Romer (1990) Aghion and Howitt (1992) Eaton and Kortum (1996), Howitt (1999, 2000)), Peretto (1998)). Finally, some important growth theories include no externalities at all (Jones and Manuelli (1990) Rebelo (1991) Acemoglu and Ventura (2002)). The evidence suggests that models with no externalities cannot explain a number of empirical patterns. Firm data, wage data, and housing or land price data have been used to test human capital externalities. Firm data requires a broad set of control variables to separate it from other sources of benefits that firms obtain from being close to each other, including forward or backward linkages, input sharing, and natural advantages. Land prices usually are not directly observable. Estimating hedonic housing models to infer human capital externalities is reasonable, but it omits information on individual workers. Other indirect methods use patent citation data to study the geographical localization of knowledge spillovers.

The first-generation endogenous growth models feature a positive relation between aggregate market size and growth that results in a positive relation between the scale of aggregate economic activity and the growth rate of income per capita. Several contributions proposed solutions based on product proliferation: Dinopoulos and Thompson (1998), Young (1998), and Howitt (1999). Aghion and Howitt (1998, 2006), Dinopoulos and Thompson (1999), Jones (1999), Peretto and Smulders (2002) for reviews of the various approaches and of the early empirical evidence. This version of Schumpeterian theory has recently received empirical support in Ha and Howitt (2007), Laincz and Peretto (2006), Sedgley (2006), Madsen (2008) and Ulku (2007).

The rest of the paper is organized as follows. Sections 2 and 3 review the main pitfalls of potential growth estimates. Section 4 overviews the various ways in which measures of public policy are considered in growth models. Sections 4 and 5 sketch a Schumpeterian model giving some insights on the consequences of tax policies and subsidies on potential output. Section 6 concludes.

2 Measurement

Determining potential growth and potential output is definitely a crucial task in order to figure out the requirement of adopting economic policies and to assess their consequences. The requirement of implementing a fiscal and/or a monetary policy depends on the output gap: economic policies may be effective only insofar as the out- put gap is negative, otherwise they will prove "excessive" as they will have only nominal effects. Consequences of economic policies thus also depend on the output gap: increasing fiscal deficits or reducing nominal interest rates for stabilization purposes when the potential output is below the actual output will prove inflationary and inefficient. Potential output and potential growth also convey key information: high potential growth may attract long-term capital flows and facilitate the vertical specialization of a domestic economy.

Potential output and the ensuing output gap are widely used by policy makers, and are thus crucial for designing an adequate if not optimal economic policy. There are two very different concepts of potential output. Some (semi-structural) methods mix them, but in general no consensus has arisen so far as regards a unique, uncontroversial estimation methodology.

From a statistical point of view, potential output is computed as the trend or smooth component of actual GDP series. The underlying concept is thus totally disconnected from a specific economic theory and cannot explain the determinants of potential output: by construction, actual GDP smoothly fluctuates around potential output in the mid-run. If economic rationale prevails, potential output is generally said to be defined as the level of output consistent with a stable inflation rate. More precisely, it is the "sustainable aggregate supply capabilities of an economy, as determined by the structure of production, the state of technology and the available inputs" (ECB, 2000).

Assessing potential output is definitely not straightforward as potential output is not "observable". Estimation techniques have been manifold in the past. On the one hand, for those economists who acknowledged the statistical view of potential output, various trend and univariate (or multivariate) methods were proposed: potential output was considered as a linear trend component of actual output , but the trend component could also be extracted by a filter (the Hodrick-Prescott (HP), the Baxter-King filter or the Kalman filter). On the other hand, for those economists who acknowledged an economic view of potential output, a second type of methodology- the production function approach - has given the possibility of identifying the various factors contributing to potential growth. Finally, recent empirical papers propose to combine multivariate filtering techniques with the production-function approach, whereas some others draw on VAR models to extract the output gap.

All types of estimation methodology have their advantages and drawbacks. Statistical methods are easy to implement but since they draw extensively on past observations of actual output, they do not give information on its determinants (see Cogley and Nason, 1995, Canova, 1998, and Claus, 2003). Potential output is defined as the permanent component of actual output, usually identified as the supply component, whereas the output gap is defined as the temporary deviation from the trend, usually identified as the demand component. As these estimates depend on past statistical information, without a structural model, they cannot serve the purpose of forecasting potential output or potential growth. Moreover, filtering methods are confronted with the end-of-period problem which creates instability of estimates. Rather than univariate filters, multivariate filters have been introduced in the literature (Kuttner, 1994). For instance, Laxton and Tetlow (1992) recommended complementing the Hodrick-Prescott filter with Phillips curve and Okun's law relationships, thus leading to semi-structural specifications of the output gap. However, this approach has several shortcomings: it requires introducing some priors on the relationships; some misspecifications can produce unpredictable outcomes, which can explain the poor real-time performance of this approach; and the contribution of the economic variables to the estimated gap can be very weak (Borio et al., 2014). For these reasons, Borio et al. (2014) have recently proposed a parsimonious multivariate filter approach which improves the real-time performance of their estimated output gap on US data with the introduction of financial variables.

Non-statistical structural methods rely on a specific economic theory and identify explicitly the factors that are driving economic growth: they can be used for forecasting purposes. Moreover, they are widely used by international institutions (OECD, IMF, etc.) and can be used for comparison purposes. The production-function approach was recommended by the EU Economic Policy Committee (EPC, 2001). Cotis et al. (2004) note that this approach should be the preferred method for estimating potential output in Europe as it is, among the array of available methods, the most consistent with policy priority, namely achieving structural long-term targets like those induced by the Lisbon Summit (the target of a trend growth of 3 per cent per year over a decade). In order to meet this target, it remains that it is of the uppermost importance to know clearly which type of structural reforms in labor, product and capital markets is likely to drive future economic growth. Nevertheless, the production-function approach is not devoid of strong drawbacks: firstly, the appropriate form (Cobb-Douglas, CES, etc.) of the production function has to be chosen but no uncontroversial method can definitely discriminate between different specifications. Secondly, structural changes like those arising from a productivity shock are difficult to incorporate in stable estimated production functions. This is particularly important after a shock to the economy has occurred: can it be said that the global financial crisis has had long lasting negative effects on productivity, which would mean a permanent decrease in potential output all over the industrialized countries? Thirdly, this approach raises the issue of how to measure unobservable variables like total factor productivity (TFP) or the equilibrium (or natural) level of unemployment. As such, data on the stocks of labor and capital may be of poor quality to implement reliable estimations of production functions.

It is highly probable that the reliance on total factor productivity (TFP) as a measure of technical progress is quite heavily biased by measurement errors. Both inputs are at stake. As for labor, the growth in labor productivity can be broken into three components: an increase in capital input per hour worked (or capital deepening), a rise in the growth of TFP or output per unit of input, and an increase in labor quality, labor input per hour worked, due to a shift toward better educated and more experienced labor force.

On labor quality, three elements are noteworthy. Firstly, it is very likely that the quality of the labor force has to do with that of education: in some countries, mostly European ones, human capital is resulting from public involvement in providing education, hence from some part of public expenditures. This would mean that those expenditures may impinge on labor productivity and, consequently, on potential output. Secondly, the relationship between labor quality and employment quality has to be somewhat scrutinized: the changing organization of work after the decay of Taylorism has dramatically deteriorated safety and health of working people. Askenazy (2004)) argues that cumulative trauma disorders were highly and positively correlated with innovative organization of work in the USA between 1984 and 1994 , and this would have been the case also in European countries since the beginning of the 1990s. The lower overall quality of employment may impinge on labor productivity and on potential output. Thirdly, labor quality is dependent on the actual level of unemployment: potential output thus depends on effective output. Long-lasting unemployment is unfavorable to labor quality as it pushes some unemployed workers to quit the labor market via early retirement schemes: the average skill of the labor force then drops automatically. High unemployment is also unfavorable to labor quality as it discourages the young and married women (generally with kids) to try to enter on the labor market. In times of crisis, these elements gain importance in trying to assess the future potential output of an economy.

As for capital, two major issues are at stake. Firstly, it has been shown (see Musso, 2004) that the measurement of TFP is very sensitive to the assumption of a constant lifespan of equipment. The acceleration of capital obsolescence led to overestimating the TFP slowdown in the USA between 1970 and 1995; and this acceleration was mainly due to the rise in the rhythm of technical progress and in the rhythm of diffusion of innovations. Secondly, adjusting prices of capital goods to better take into account the evolution in the quality of equipment (following Gordon, 1990) also drastically limits the contribution of TFP to potential growth and, conversely, accentuate the role of capital accumulation.

Two striking results emerge from estimations of potential growth and the output gap. First, the sensitiveness of estimations to the chosen methodology can be quite large. Lequien and Montaut (2014) compare, on French and Eurozone data, potential growth and the output gap stemming from four approaches: two structural, one semi-structural and one related to principal component analysis. They conclude that potential growth in the Eurozone in 2012 lay in the range [0.2; 1] and the output gap in the range [-2.7; -1.5]. In terms of benchmark Taylor-rule monetary policy, a difference of 1.2 in the output gap means a change of 60 basis points in the nominal interest rate, whereas according to a rule-of-thumb for the computation of automatic stabilizers, the same difference makes a change of 0.6 percent of GDP in the deficit. Second, estimations of potential growth fluctuate from one year to another and the reason behind cannot always be attributed to a sharp international crisis. Lequien and Montaut (2014) show that under the structural approach, potential growth in France was 2.4 in 2000, 2.1 in 2002, 1.7 in 2006 although the global financial had not already started. These variations seem at odds with the estimation of long run growth.

Finally, it is noteworthy that some empirical papers propose combining multivariate filtering techniques with the production-function approach. This methodology thus combines a model-based approach to estimate potential output with explicit statistical assumptions concerning the estimation of the potential values of the components of the production function. Unfortunately, those sophisticated techniques do not help to discriminate between different specifications (Cobb-Douglas, translog, etc.) of the production function and may therefore remain highly sensitive to the chosen specification.

As for the SVAR approach, it combines an empirical model with long-run restrictions in the vein of Blanchard and Quah (1989). This method requires fewer restrictions on the parameters than a multivariate filter; it helps to overcome the instability of the estimated gap near the end of the sample; and it is flexible enough to permit an investigation of the incidence of the foreign sector on domestic potential output (Claus, 2003). Moreover, this approach can be used for forecast purposes (Cesaroni, 2008). The usual drawback of this method relates to the identification of supply and demand shocks and its incidence on the relationship between the output gap and potential output (Balfoussias, 2008). The former stems from the demand side, whereas the latter derives from the supply side. By assumption, the identification procedure poses a restriction on the long-run impact of a demand shock: it is nil. Consequently, supply and demand shocks are assumed to be uncorrelated; hence, the output gap and potential output are uncorrelated as well, which makes little sense, at least in the short run.

3 Delays

The methodology surrounding the estimation of potential output crucially depends on the time horizon: in the short run, the capital stock is assumed constant and therefore, potential output only depends on the maximum utilization of inputs - capital and labor. Inflation, which ultimately reveals a positive output gap, stems from the rise of actual utilization rates towards their maximum; therefore, the inflation rate is crucial in designing the maximum utilization rate of inputs: once it is growing, one can say that the gap between the actual and maximum rate has narrowed. However, the degree of acceptance of inflation in the economy is instrumental in the design of potential output (Le Bihan et al, 1997; Passet et al., 1997). If the aversion towards inflation is low, public authorities (governments, central banks) will not react toughly; a higher degree of acceptance of inflation will lead to higher growth in the short run, hence to higher potential growth. In contrast, if the aversion towards inflation is high, public authorities will react toughly: actual and potential growth will be lower than in the former case. As a consequence, assuming a stable potential output in the short run requires assuming that the aversion towards inflation is known and constant over time.

As European economies have moved from low to strong aversion vis-à-vis inflation since the mid-Eighties, it can be inferred that EU potential output may well have been underestimated ever since. Imagine a rise in the inflation rate produced by a temporary surge of investment, possibly inducing innovations. Under strong aversion towards inflation, this inflation hike triggers a tough monetary reaction which not only curbs inflation but also the future innovation and future supply of goods.

Moreover, the relatively inertial behavior of European policy makers after economic shocks could be attributable to a social norm (Fitoussi and Le Cacheux, 2005): a lower aversion vis-à-vis inequalities would tend to let public authorities accept a higher natural rate of unemployment than in the Seventies.

In the mid-run, potential output depends on the speed of and extent to which capital is accumulated. Technical progress is no longer considered as a constant data and its determinants have to be assessed. Measuring the dynamics of capital accumulation and the diffusion and determinants of technical progress remains a major theoretical, methodological and empirical issue.

4 Endogenous Growth and Economic Policies

The neoclassical growth model à la Solow states that actual growth per capita is conditional on capital and labor accumulation and on exogenous technological progress. Assuming decreasing returns to scale, output growth equals that of the population plus technical progress in the long run. Within this framework, it is straightforward that economic policies are devoid of an impact on growth per capita in a situation in which the economy is in steady state. Nevertheless, a large body of literature has used the Solow model as a framework to understand some first order effects of tax and spending policies. In fact, if the steady state level of capital relative to output is pushed forward, for instance by a subsidy to investment, or by a policy of forced saving, the economy will exhibit positive although declining growth for many years after the implementation of the policy. Piketty (2014) uses for instance the Solow model as the conceptual framework to explain the dynamics of the wealth over income ratio and its potential effect on inequality.

The so-called "New" growth theory acknowledges the endogenous nature of technical progress and assigns a key role to fiscal policy as a determinant of long-run economic growth. The new theory of endogenous growth has introduced many new elements potentially under the influence of the government. Therefore, it represents a richer conceptual framework to evaluate European economic policies.

A line of research has emphasized the role of producers' market power both as a driver for innovation, but also as a possible source of welfare losses for consumers. The classic work of Romer (1990) and of Aghion and Howitt (1992), which span a large body of literature on growth, assume that firms enter the market because of the prospect of monopolistic extraction.

A second line of research took the road of human capital. Although in the initial work of Lucas (1988) education is seen an investment of individuals, the subsequent literature has amended the model to allow for public spending in education (see for instance Glomm and Kaganovich (2003)). Whether human capital is a key element of long run growth is still under scrutiny. In particular, the empirical evidence presented in Benhabib and Spiegel (1994), which implies that the initial level of human capital but not its growth rate is positively linked to long run income growth, is still largely unchallenged.

Both approaches assume some sorts of externality as an ingredient for long run growth. In the technological-type of progress models, it is the stock of knowledge developed by other firms. In the human capital knowledge is social learning. In either case, the conclusion is that the decentralized market does not invest enough in knowledge.

A third line of research emphasizes the role of public capital. An early formalization of this approach is presented in Barro (1990). Barro and Sala-i-Martin (1992) considers three types of public capital: one is a pure public good, that is, it has the characteristic of being non-rival and non-excludable. A second one is a private good (rival and excludable) but provided by the government. A third type of is a good subject to congestion – non-rival when it is used by a few individuals, but rival when the intensity of its uses goes over a certain limit. In two out of the three cases, that is in the cases where public capital has the characteristic of being non-rival, the provision by the government has unambiguous positive effects on growth. In this context, public intervention financing fundamental research, infrastructures, etc., may substantially enhance economic growth above the steady-state compatible with the assumption that goods and labor markets clear. Unfortunately, empirical evidence on the links between public capital and economic growth is still debatable (see Romp and de Haan, 2007). According to Bom and Ligthart (2009) and their meta-analysis on this topic however, the output elasticity of public capital spending is always positive.

The first generation of endogenous growth model considered two types of benefits derived from technological progress: One is due to the 'variety' expansion, that is the idea that the production process becomes more efficient with a greater variety of good, or that the individual's utility increases as the consumption options expands. A second is the improvement in efficiency within an existing line of production, which can be driven either by incumbent firms or by new entrants. A more recent line of research has merged these two aspects of vertical and horizontal innovation. The question is not anymore what are the factors that can accelerate growth, but how public policy affects the balance between the various growth channels. In the remaining part of the paper we elaborate more formally on the tax policies implications of this more recent body of literature.

5 Dynamics of the Industry and Potential Growth

One way of interpreting the gap between the current and the potential GDP is that the economy is operating at a scale below the long run one. In this section we use a simple Schumpeterian growth model to show the adjustment processes that follows a number of policy measures, including taxes and R&D subsidies, when the dynamics are driven by the entry of new firms and by the firms' investment decisions. We abstract from monetary policy. We consider routine-type of innovation carried out by incumbent firms rather than vertical innovation pushed forward by outsiders (see Aghion and Howitt (2005) for a review of this line of research). The experiments are inspired by Iacopetta and Peretto (2014).

5.1 Baseline model

In a closed economy there is a large number of firms operating in perfect competition that produce a consumption good by using a variety of non-durable intermediate goods and unskilled labor. There is no neoclassical physical capital. Intermediate good firms improve the quality of their production by investing systematically in innovation. All variables are functions of (continuous) time but to simplify the notation we omit the time argument unless necessary to avoid confusion. The economy is populated by a continuum of households of mass $L = L_0 e^{\lambda t}$, $L_0 \equiv 1$. A household supplies labor and trades assets in competitive markets.

Households. The representative household has preferences

$$U(t) = \int_t^\infty L(s) e^{-\rho(s-t)} \log c(s) ds, \quad \rho > \lambda \geq 0 \tag{1}$$

where t is the point in time when the household makes decisions, ρ is the individual discount rate, and c is per capita consumption. Since each household is endowed with one unit of time, L is the total endowment of labor. Each household supplies labor inelastically and thus faces the flow budget constraint (in per capita terms)

$$\dot{a} = (r - \lambda)a + w - c, \tag{2}$$

where a is assets holding, r is the rate of return on assets and w is the wage. The intertemporal consumption plan that maximizes (1) subject to (2) consists of the Euler equation

$$\frac{\dot{c}}{c} = r - \rho, \tag{3}$$

the budget constraint (2) and the usual boundary conditions.

Final producers. There are J final good firms. A competitive representative firm j produces a final good Y_j that can be consumed, used to produce intermediate goods, invested in the improvement of the quality of existing intermediate goods, or invested in the creation of new intermediate goods. The final good is the numeraire so its price is $P_Y \equiv 1$. Final good firm j produce according to the following technology

$$Y_j = \int_0^N X_{i,j}^{\theta} \left[Z_i^{\alpha} Z^{1-\alpha} \frac{L_j}{N^{1-\sigma}} \right]^{(1-\theta)} di, \quad 0 < \theta, \alpha < 1 \tag{4}$$

where N is the mass of intermediate goods, $X_{i,j}$ is the quantity of intermediate good i, and L_j is labor. Quality is the ability of a good to raise the productivity of the other factors: the contribution of good i depends on its own quality, Z_i, and on the average quality, $Z = \int_0^N (Z_i/N)\, di$, of intermediate goods. Social returns to quality are equal to 1. The parameter σ is instead the social returns to variety. The first-order conditions for the profit maximization problem of the final producer yield that each intermediate producer faces the demand curve

$$X_{ij} = \left(\frac{\theta}{P_i} \right)^{\frac{1}{1-\theta}} Z_i^{\alpha} Z^{1-\alpha} \frac{L_j}{N^{1-\sigma}}, \tag{5}$$

where P_i is the price of intermediate good i. The first-order conditions then yield that the final producer pays total compensation

$$\int_0^N P_i X_{ij} di = \theta Y_j \quad \text{and} \quad w L_j = (1-\theta) Y_j \tag{6}$$

to intermediate goods and labor suppliers, respectively. Because households derive no utility from leisure, the overall supply of labor is the same as the size of the population: $\int_0^J L_j dj = L$. Therefore,

$$X_i = \left(\frac{\theta}{P_i} \right)^{\frac{1}{1-\theta}} Z_i^{\alpha} Z^{1-\alpha} \frac{L}{N^{1-\sigma}}, \tag{7}$$

and

$$\int_0^N P_i X_i di = \theta Y \quad \text{and} \quad w L = (1-\theta) Y$$

where $X_i = \int_0^J X_{ij} dj$ and $Y = \int_0^J Y_j dj$.

Intermediate producers. The typical firm producing an intermediate good i operates a technology that requires one unit of final good per unit of intermediate good and a fixed operating cost $\phi Z_i^{\alpha} Z^{1-\alpha}$, also in units of final good. The firm can increase the quality of its intermediate good according to the technology

$$\dot{Z}_i = I_i, \tag{8}$$

where I_i is investment in quality, in units of final good. Using (7), the firm's gross profit (i.e., the profit before investment expenditure) is

$$\Pi_i^G = \left[(P_i - 1) \left(\frac{\theta}{P_i} \right)^{\frac{1}{1-\theta}} \frac{L}{N^{1-\sigma}} - \phi \right] Z_i^{\alpha} Z^{1-\alpha}. \tag{9}$$

At time t, the intermediate firm would choose for $s \in [t, \infty)$ paths of the product's price, $P_i(s)$ and investment, $I_i(s)$, so to maximize

$$V_i(t) = \int_t^{\infty} e^{-\int_t^s r(v)dv} \left[\Pi_i(s) - I_i(s) \right] ds \tag{10}$$

subject to (8) and (9), and taking the paths of the interest rate, $r(s)$, and of average quality, $Z(s)$, as given.

Next, we need to specify the process of formation of intermediate firms. At time t, a household member who wants to found a new firm has to sink $\beta X(t)$ units of final good. Because of this sunk cost, the new firm cannot supply an existing good in Bertrand competition with the incumbent monopolist but must introduce a new good that expands product variety. New firms enter at the average quality level, and therefore at average size (this simplifying assumption preserves symmetry of equilibrium at all times).

5.1.1 Optimal innovation and the entry decision

The net profit generated by an intermediate firm is

$$\Pi_i \equiv (P_i - 1) X_i - \phi Z_i^{\alpha} Z^{1-\alpha} - I_i. \tag{11}$$

Therefore, the optimal price and the optimal path of innovation are pinned, the first-order conditions of the associated Hamiltonian (not reported) with respect to P_i, I_i, Z_i lead to the following monopolistic price and return to investment in quality

$$P_i = \frac{1}{\theta}, \tag{12}$$

$$r_Z = \alpha \left[\left(\frac{1}{\theta} - 1 \right) \frac{X_i}{Z_i} - \phi \left(\frac{Z}{Z_i} \right)^{1-\alpha} \right]. \tag{13}$$

In a later extension of this model we will consider a situation in which the firm internalizes the effects that its pricing decisions has on its share of the market. As in most endogenous growth model with market power, the rate of return on innovation is increasing in the mark-up, for a given level of production X_i. However in this environment with endogenous entry, the change in mark up triggers general equilibrium effects that can actually bring down the growth rate of the economy. The free-entry condition is given by

$$\beta X_i(t) \leq V_i(t), \tag{14}$$

where on the left-hand side is the cost of entry which is assumed to be proportional to the scale of operation of the firm. Eq. (7) clarifies that this is also increasing in the state of technological level of the firm Z_i. The right-hand side is the value of the new firm (specified below) defined as

$$V_i(t) = \int_t^{+\infty} e^{-\int_t^s r(v)dv} \Pi_i(s) ds. \tag{15}$$

If the expected flow of profits is not large enough to justify sunking $\beta X_i(t)$ there is no entry and growth is driven only by incumbent firms. Conversely, if entry is profitable, because everybody can attempt to set up a new firm, in equilibrium Eq. (14) holds as an equality.

When entry is profitable, condition in Eq. (14) and equation (15) yield

$$r_N = \frac{\Pi_i}{\beta X_i} + \frac{\dot{X}_i}{X_i}, \tag{16}$$

This expression shows that the return to entry — i.e., the return to setting up new corporate entities— is given by the dividend price ratio plus capital gains or losses.

5.2 Equilibrium

We now study how the equilibrium conditions drive the allocation of final output Y between consumption, production of intermediate goods, innovation and the set up of new firms. We also look at the evolution over time of the firm's market size and of the pace of technological change. In a first step we rearrange the flow of final good j by using the property that $PX_{ij} = \theta Y_j$ and assuming symmetry across firms. We can thus express firm's j flow of output as $Y_j = \left(\frac{\theta}{P}\right)^{\frac{\theta}{1-\theta}} N^{\sigma-1} L_j \int_0^N Z_i^{\alpha} Z^{1-\alpha} di$. From what follows we will impose symmetry across firms, hence $Z_i = Z$. Hence summing over all final good producers we obtain

$$Y = \left(\frac{\theta}{P}\right)^{\frac{\theta}{1-\theta}} N^{\sigma} Z L, \tag{17}$$

where $Y = \int_0^J Y_j dj$. The definition of gross profit (9) and equations (13) and (16) show that the returns to innovation and to entry depend on the quality-adjusted gross cash flow of the firm $(P-1) X_i/Z_i$ — i.e., revenues minus variable production costs, all scaled by quality — since this is the appropriate measure of profitability for firms that spread fixed costs, including the cost of developing quality-improving innovations, over their volume of sales. Scaling by quality is required to make variables stationary in steady state. Hence, Eqs. (13) and (16) yields the following expressions for the returns to innovation and to entry:

$$r_Z = \alpha \left[(P-1)\,\omega x - \phi\right]; \tag{18}$$

$$r_N = \frac{1}{\beta\omega}\left[(P-1)\,\omega - \frac{\phi + z}{x}\right] + \frac{\dot{x}}{x} + z. \tag{19}$$

where $\omega \equiv \left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}$, $x \equiv L/N^{1-\sigma}$ – this will play the role of our state variable, for it proxies the size of the market captured by each intermediate good firm. The variable and z is the growth rate of Z. These two equations show that in equilibrium the return to innovation is given by the quality-adjusted gross cash flow, which is increasing in labor use in the downstream final sector (since production of final goods drives the demand for intermediate goods) and decreasing in the mass of firms. It should be clear, however, that from the viewpoint of the managers of incumbent firms and of the founders of new firms the critical market size variable is total expenditure on intermediate goods, θY; the terms L and N^{σ} enter the calculation of the returns once we want to trace the general equilibrium determinants of θY.

Finally, we compute assets of this economy that are given by the overall amount of equity shares of intermediate firms. Therefore, the overall wealth of the households at time t equals

$$A(t) = \int_0^N V_i(t)di.$$

5.3 Dynamics

We can conveniently follow the evolution of the economy through the movements of the state variable x. Indeed using the households budget constraints, the above definition of assets, and the free entry condition, and the Euler Equation, one can show that the differential equation of the consumption output ratio $c = C/Y$ admits only one unstable positive fixed point: $1-\theta+(\rho-\lambda)\,\beta\frac{\theta}{P}$. Hence when n and z are both positive the consumption output ratio is constant. Conversely, when entry is not yet profitable one can show that the $c = 1-\theta+\frac{\theta}{P}\,(P-1)-\frac{\phi+z}{\omega^{\theta}x}$[2]. When x is too small and there is no entry, the consumption ratio is increasing in x because firms earn escalating rents (uncontested by entrants) from the growing size of the market (recall that we postulate population growth). Such rents are distributed to the shareholders who consume them. When x is sufficiently high and there is entry, in which case the rents are capped and the consumption ratio is constant.

It is possible to calculate analytically thresholds of x above which innovation and entry are profitable, respectively by setting to zero the left hand side of Eqs. (18) and (19) hold) the level. Let x_Z and x_N denote the two thresholds, respectively. Then we have that when $x > x_Z$

$$z(x) = \frac{\left((P-1)\,\omega x-\phi\right)\left(\alpha-\frac{\sigma}{\beta\omega x}\right)-(1-\sigma)\,\rho-\sigma\lambda}{1-\frac{\sigma}{\beta\omega x}} \tag{20}$$

and when $x > x_N$

$$n(x) = \frac{1}{\beta\omega}\left((P-1)\,\omega-\frac{\phi+z\,(x)}{x}\right)-\rho+\lambda \tag{21}$$

Whether x_N is larger or smaller than x_Z is of crucial importance in defining the sequence of development. In what follows we focus on a scenario that seems to accord more with historical

[2] When there is no entry, total output is used for consumption, intermediate goods, operating cost, and possibly innovation. $Y = C + NX + \phi NZ + zNZ$. Noticing that $NX = \theta^2 Y$ and that $NZ = \frac{1}{x}\left(\frac{\theta}{P}\right)^{-\frac{\theta}{1-\theta}} Y$, we obtain: $1 = c + \theta^2 + (\phi + z)\frac{1}{x}\left(\frac{\theta}{P}\right)^{-\frac{\theta}{1-\theta}}$.

evidence: $x_N < x_Z$. [3]. The definition of x implies that this obeys the differential equation

$$\frac{\dot{x}}{x} = \lambda - (1-\sigma)\, n(x). \tag{22}$$

Combining the above expressions for $n(x)$ and $\frac{\dot{x}}{x}$ one gets

$$\frac{\dot{x}}{x} = \sigma\lambda + (1-\sigma)\rho - (1-\sigma)\frac{1}{\beta\omega}\left((P-1)\,\omega - \frac{\phi}{x}\right).$$

Therefore, the economy can crosses the threshold for quality innovation in finite time. Intuitively as the quality-adjusted gross profitability of firms, $(P-1)\,X/Z$, rises the dissipation of profitability due to entry gains sufficient force to induce firms to initiate in-house quality-improving operations.

5.4 The steady state

To refine the intuition on the mechanisms that causes long run changes in this economy, it is useful to determine the steady state value of the interest rate, the innovation rate, and of the entry rate. The steady state values will be denoted with an asterix. First, it is easy to observe that for x to be constant, it must be that

$$n^* \equiv \frac{\lambda}{1-\sigma} \tag{23}$$

. From the saving behavior of the household we obtain

$$r^* = \rho + \sigma n^* + z^*.$$

Second, the returns to quality investment and to entry (19) and (18) lead to:

$$z = \alpha\,(P-1)\,\omega x - \alpha\phi - (\rho + \sigma n^*); \tag{CI}$$

$$z = \left[(P-1) - \beta\,(\rho + \sigma n^*)\right]\omega x - \phi. \tag{EI}$$

After some algebra, we obtain:

$$x^* = \frac{(1-\alpha)\,\phi - (\rho + \sigma n^*)}{(1-\alpha)\,(P-1) - \beta\,(\rho + \sigma n^*)}\left(\frac{\theta}{P}\right)^{-\frac{1}{1-\theta}}; \tag{24}$$

$$z^* = \frac{\left[\alpha\phi + (\rho + \sigma n^*)\right]\beta - \alpha\,(P-1)}{(1-\alpha)\,(P-1) - \beta\,(\rho + \sigma n^*)}\,(\rho + \sigma n^*). \tag{25}$$

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[3] After some algebra one finds that is true as long as $\left((P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x_N - \phi\right)\left(\alpha - \frac{\sigma\Theta}{\gamma\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x_N}\right) < (1-\sigma)\,\rho + \sigma\lambda$.

Also some technical conditions are needed for entry x_N to be finite and to insure that the resulting equilibrium is actually a stable Nash equilibrium.

Table 1: Baseline Case: Parameters Values

Parameters							Steady State Values				
Production and Entry					Households			Percentage			
α	σ	θ	ϕ	β	ρ	λ	x	z	n	y	r
0.16	0.2	0.3	1	13.76	0.035	0.01	17.33	1	1.25	1.25	4.75

5.5 GDP and welfare

To complete the characterization of the model, we examine the effects of corporate governance frictions on GDP and welfare. Let G denote the GDP of this economy. Subtracting the cost of intermediate production from the value of final production and using (7) yields

$$GDP \equiv G = Y - N(X + \phi Z) = \left[1 - \frac{\theta}{P}\left(1 + \frac{\phi Z}{X}\right)\right] Y = \left[1 - \frac{\theta}{P}\left(1 + \frac{\phi}{\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x}\right)\right] Y,$$

where $P = 1/(1+\Omega)\theta$. The term in brackets is increasing in X, and therefore in x, because the unit cost of production of the typical intermediate firm falls as its scale of operation rises. In steady state the growth rate of final output and GDP per capita is

$$\left(\frac{\dot{Y}}{Y}\right)^* - \lambda = \frac{\sigma\lambda}{1-\sigma} + z^*. \tag{26}$$

6 Taxes and Subsidies

In this section we introduce taxes on corporate profits, financial income, labor, and consumption. We also consider a form of R&D deduction which reduces the intermediate good's firm corporate tax liabilities. The main objective of this section is to understand how the entry decision and the incumbent choice of quality improvement is affected by a wide variety of fiscal policy instruments. We will assume that the government runs a balanced budget and that taxes are partly or totally rebated to consumers on the same period they accrue to the government and partly are used to finance the government activities. We are mostly concerned with the distortionary effects of taxes. For this reason we treat government spending, when this is positive, as unproductive. Nevertheless taxes do not have necessarily negative effects on growth, because they may correct monopolistic distortions. All corporate and financial taxes, when are rebated to the households are given directly in form of consumption goods. The household budget constraint is

$$\dot{a} = (1 - \tau_w)w + (1 - \tau_a)ra - (1 + \tau_c)c - na + v$$

where τ_w, τ_a, and τ_c are time constant tax rate on labor income, financial assets, and consumption. The variable v is the amount of per capita transfers which consists of $\tau_w w + \tau_c c$. For brevity we consider only one type of tax rate on financial assets τ_a.[4] Each firm's tax liability is proportional

[4] For a distinction between tax rate on capital gains and on distributed dividends in a similar framework, see Peretto (2007).

to gross profits:

$$\tau_\Pi[(P-1)X_i - \phi Z_i - eI]$$

where $0 < \tau_\Pi < 1$ and $e \geq 0$ measures the amount of R&D expenditures that can be deducted. Hence the firm's flow of profit net of taxes is now

$$\Pi^N = (1-\tau_\Pi)[(P-1)X_i - \phi Z_i - \mu I]$$

where $\mu = \frac{1-\tau_\Pi e}{1-\tau_\Pi}$. The firm's value is still defined by (15) as long as Π is being replaced with Π^N. Hence,

$$r = \frac{\Pi^N}{V} + \frac{\dot{V}}{V}.$$

Aside from any negative effect on the capital gains, taxes reduce the interest rate by dampening down the flow of profits.

One can verify that the returns to innovation and to entry become

$$r_Z = \frac{\alpha}{\mu}\left[(P-1)\,\omega x - \phi\right] \tag{27}$$

and

$$r_N = \frac{(1-\tau_\Pi)}{\beta\omega}\left[(P-1)\,\omega - \frac{\phi+\mu z}{x}\right] + \frac{\dot{x}}{x} + z. \tag{28}$$

Intuitively, when the R&D expenditures are fully deductible ($\mu = 1$), for a given interest rate, the pattern of innovation expenditures is not affected by the corporate taxes, for these take away a constant proportion of profits. Conversely, the return to entry goes down with the corporate tax rate.

The Euler Equation is clearly affected by the tax on financial assets:

$$\frac{\dot{c}}{c} = r(1-\tau_a) - \rho.$$

By combining the three equations and setting $\dot{x} = 0$, and observing that $\frac{\dot{c}}{c} = \sigma n + z$, one obtains the CI and SE loci under taxation:

$$z = \frac{\alpha(1-\tau_a)}{\mu}\left[(P-1)\,\omega x - \phi\right] - (\sigma n + \rho). \tag{29}$$

and

$$z = \frac{1}{\tau_a\beta\omega x + \varphi}\frac{1}{\mu}\left\{\varphi\left[(P-1)\,\omega x - \phi\right] - \ (\sigma n + \rho)\beta\omega x\right\} \tag{30}$$

where $\varphi \equiv (1-\tau_a)(1-\tau_\Pi)$.A rise in the corporate tax causes a clock-wise rotation of the entrepreneurial innovation curve (EI): to maintain the same level of innovation firms have to be bigger in order to spread the cost of innovation across a greater amount of production. It also affects the corporate innovation (CI) loci because the reduction of the tax base brought about by R&D spending amounts at saving on taxes. Said it differently, a higher corporate tax is equivalent to a greater

R&D subsidy (s) which causes an anti-clockwise rotation of the CI curve. As a result level of the equilibrium innovation rates higher. Intuitively, the corporate taxes have negative distortionary effects on entry, that slows down the set up of new firms, and a create a positive distortion with respect to R&D investments. If the entry distortion is sufficiently large, firms will have bigger size in the economy with a higher corporate tax.

The financial asset tax does not alter directly the R&D subsidy. In this case both margins of innovation are negatively affected by the tax, implying a clockwise rotation of both loci. Firms grow bigger, but the net effect on the long run innovation rate is ambiguous.

When $n > 0$ assets market equilibrium requires

$$A = NV = \beta NX = \beta \frac{\theta}{P} \cdot Y, \tag{31}$$

which says that the wealth ratio A/Y is constant. This result and the saving schedule (3) allow us to rewrite the household budget (2) as the following unstable differential equation in $c \equiv C/Y$ with the same characteristics of the tax-free economy.[5]

6.1 Taxes and R&D subsidies: Comparative Static

We explore first the steady state effects of changes in the tax code. The main question we focus on is the welfare consequences of the introduction of corporate taxes, financial assets taxes, and a combination of taxes and R&D subsidies. In order to focus on the distortionary effects of taxes we assume that the government rebates all the revenues raised by the two taxes, net of any R&D subsidies, in form of consumption .

A surprising result that emerges is that taxes may be welfare improving, at least when there is no initial taxation. The distortion introduced by taxes indeed can correct other underlying distortions to the point of increasing general welfare. For instance, the economy may under invest in innovation, because firms do not fully internalize the returns of their R&D investments. Traditionally an R&D subsidy is called upon to ameliorate the issue of suboptimal investment. In this framework, however, there is an additional and less evident tool that the policy maker can use: make it more costly for firms to enter the market or make it less profitable for households to start-up the creation of new firms. Such a policy would of course depress the dynamics of the industry, but at the same time would make relatively more profitable to invest in innovation. The total welfare and growth consequences of a change in the tax policy will depend on the relative strength of these two phenomena. In what follows we go more into the details of this mechanism. First, we look at the long run through a number of comparative static illustrations. Then we elaborate on the adjustment process and on welfare changes.

Before proceeding it is important to clarify that in an economy with taxes two steady state equilibria may emerge. This is due to the fact that the entry arbitrage condition becomes more

[5] The consumption-output ratio would depend on the financial income and corporate taxes if these were partially rebated to the households. In particular, because firms' profits are not a constant proportion of the output, rebating corporate taxes would imply that the consumption-output ratio varies with the state variable x.

and more concave with the introduction of corporate and financial income taxes. One such a case is shown in Fig. (6.1). However, only the equilibrium in which the EI line hits the CI line from below is stable. This is the one on which we focus our attention. Indeed, because our experiments start with an initial state of the economy in which there are no taxes, this is also the unique steady state equilibrium.

The introduction of a corporate tax does not alter the firm's R&D investment behavior, because the tax is proportional to the gross profits of the firm. Therefore the CI locus is unaffected. Conversely, the reduction of net profits does introduce a distortion in the entry decision causing a downward shift of the EI curve. In the long run the lower entry rate will lead to greater size, which tends to make R&D investment more profitable. The final result, is an economy with relatively fewer firms of greater dimension that invest more into corporate R&D. This result is illustrated in the top plot of Fig. (6.1).

A tax on the interest earned on assets, has the more ambiguous effects because it alters downwards both arbitrage condition. Because the net return on bonds goes down, a lower rate in innovation is needed to keep the firm's internal rate of return in line with outside options. Similarly, a lower innovation rate would be enough to keep entry profitable. If the CI curve shifts relatively more, as in the middle plot of Fig. (6.1), in the long run there will be greater investment in innovation.

The third observation concerns the introduction of R&D subsidies. From the point of view of a new firm entering the market, this looks like a reduction in the corporate tax liabilities. It is then not surprising that the CI curve moves in the opposite direction relative to the situation in which corporate profits are introduced. But also the investment decision is now affected, because the R&D subsidy is equivalent to a reduction in the cost of innovation. Because both loci move in the same direction, in principle the final effect on the innovation rate is ambiguous. Under some standard parameters, however, the entry condition is affected more significantly; therefore innovation, in the long run, accelerates.

6.2 Dynamics

Next we study the effect of corporate and asset taxes on the innovation and on the entry rate. The corresponding equation of (20) and (21) are

$$z(x) = \frac{1}{\nabla}\left\{\frac{1-\tau_a}{1-s}\alpha((P-1)\,\omega x - \phi) - \rho - \frac{\sigma}{l}[\varphi((P-1)\,\omega - \frac{\phi}{x}) + (1-\tau_a)\lambda - \rho]\right\} \tag{32}$$

and

$$n(x) = \frac{1}{l}\left\{\frac{(1-\tau_\Pi)(1-\tau_a)}{\beta\omega}\left[(P-1)\,\omega - \frac{\phi+(1-s)z(x)}{x}\right] + (1-\tau_a)(\lambda+z) - (z+\rho)\right\}, \tag{33}$$

respectively, where $l = (1-\tau_a)\,(1-\sigma)+\sigma$, and $\nabla \equiv 1 - \frac{\sigma}{l}(\frac{\varphi\mu}{x} + \tau_a)$. The growth rate of x is still given by (22).

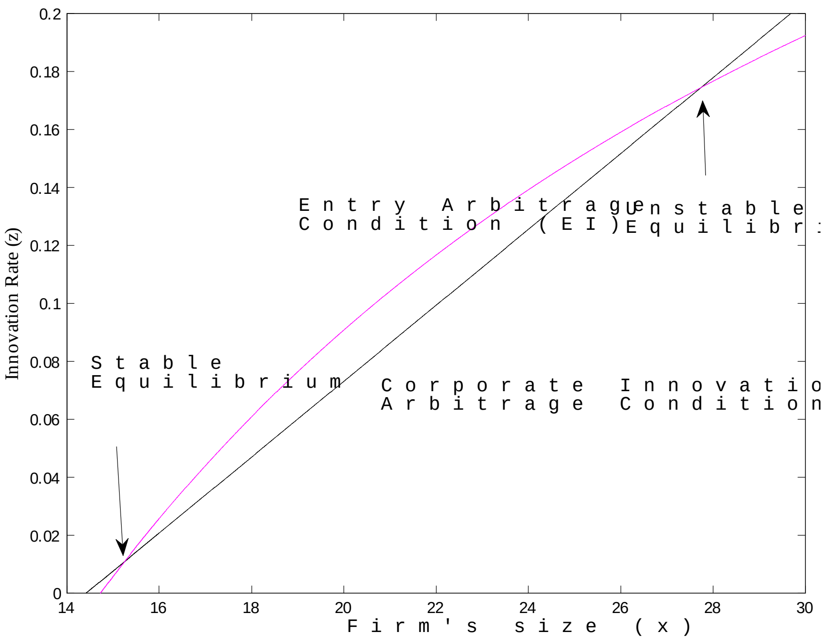

Figure 1: Multiple Equilibria

Note: Multiple Steady State Equilibria may arise with corporate and financial income taxes. The plot is generated under following parameters:

$\alpha = 0.25$, $\beta = 6$; $\phi = 0.95$; $\alpha = 0.17$; $\theta = 0.3$; $\sigma = 0.2$; $\rho = 0.02$, $\lambda = 0.01$, $\mu = 1$, $\tau_a = 0.3$, $\tau_{\Pi} = 0.4$.The eigenvalue associated to the stable (unstable) equilibrium is -0.38% (0.22%).

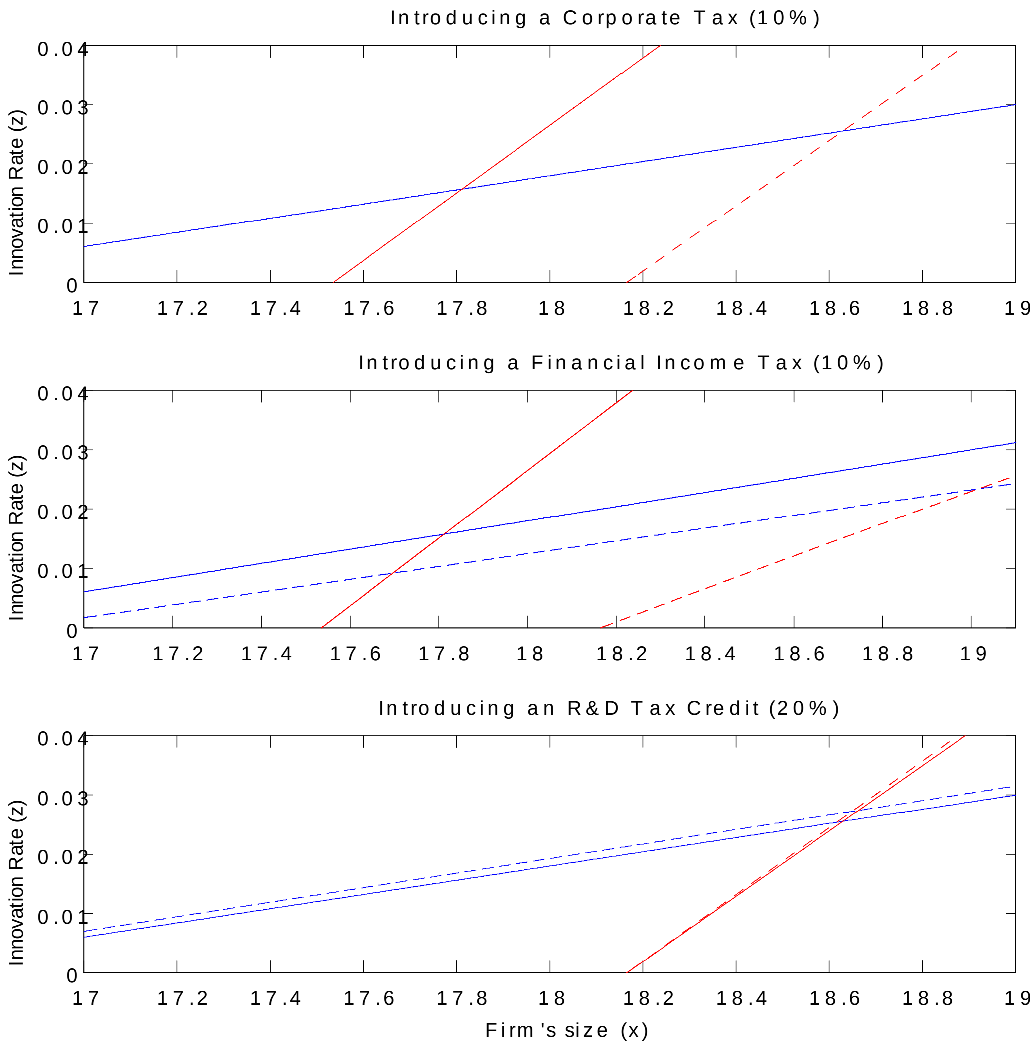

Figure 2: Tax Policy Experiments – Comparative Static

Note: The first and second plot from the top show the long run effect of introducing a corporate and a financial income tax into a free-tax economy. In the bottom plot an R&D tax credit is brought from 100 to 120 percent of expendability in an economy that has a corporate tax rate of 10%.

The government output ratio, G/Y, recipes can also be expressed as a function of the firm's size. Because the sum of the financial and corporate taxes

$$G = rA\tau_a + \tau_\Pi[(P-1)X_i - \phi Z_i - dI]N.$$

after some algebra this becomes

$$G/Y \equiv \varrho(x) = \tau_a \frac{\alpha}{\mu}\left[(P-1)\,\omega x - \phi\right]\beta\frac{\theta}{P} + \tau_\Pi[(P-1)\theta^2 - (\phi+d)\frac{1}{x\left(\frac{\theta}{P}\right)^{\frac{\theta}{1-\theta}}}].$$

6.3 Welfare

In this section we consider the welfare implications of fiscal policy. The framework we propose is that of comparing the welfare of an economy hit by a policy shock against one that stays on its long run path. As in the previous section we deal with taxes on profits, taxes on financial income, and R&D subsidies. Although we allowed for labor and consumption taxes, their welfare implications are less interesting. Indeed, the absence of the leisure choice does not allow either tax to generate distortions. In order to make sure that welfare differences are solely due to distortionary effects, in this section all taxes are rebated to consumers. For simplicity the financial and corporate taxes are rebated in form of consumption. Hence no saving decision is taken on these resources. Formally, the welfare we calculate is on the pattern of $(c+g)y$, where c and g are ratio of private consumption and government revenues relative to net output. A common theme in illustrations that follow is the rebalancing of entrepreneurial and corporate innovation as a result of a policy shock. Because these tend to act in opposite directions, growth and welfare result can be ambiguous.

Table (2) summarize the long run effect of the proposed experiments as well as the overall change in welfare. The first row refers to the benchmark economy where not taxes are levied and no subsides are in place.

Fig. (6.3) illustrates the impulse responses to the introduction of a 1% tax rate on interest earnings. Because both margins of innovation are negatively affected, in the short run – which actually can last several decades – the tax will slow down entry and corporate innovation. Hence the tax free economy grows faster. Nevertheless, as over the transition the size of the firm increases, it becomes more and more profitable to invest in R&D. After a while there is a reverse of fortunes between the two economies. In the current example this happens quite far away in the future, therefore, welfare, evaluated from the today's point of view, is greater in the tax-free economy.

In a second experiment, shown in Fig. (6.3), we study the introduction of a 1% corporate tax.

In the long run, this shock diverts resources away from entrepreneurial innovation and drives them towards corporate innovation. Intuitively, because the lower net profit depress the value of companies, households are more reluctant in establishing new firms. The return of incumbent firms also goes down for the same reason, but there is an additional effect favoring them. The lower entry rate, means that the existing firms can grab a larger share of the market. Because of the larger size, in the long run their rate of innovation is higher.

Table 2: Baseline Case: Parameters Values

Policy Parameters			Steady State Values					Welfare
				Percentage				
τ_Π	τ_a	μ	x	z	n	y	r	
0	0	1	17.96	1.75	1.25	2	5.5	-
0	0.01	1	18.06	1.81	1.25	2.06	5.62	0.969
0.01	0	1	18.03	1.84	1.25	2.09	5.59	1.011
0.01	0	1.02	18.03	1.84	1.25	2.09	5.59	1.012

Note: The first row recalls the steady state values of the economy under the same parameters as in Table (1). The remaining rows report the long run effects of a change in one or more tax policy parameters. The last column records the ratio of the household's level of welfare after the shock over that before the shock.

In the short run, the size of the firms is given. As a result, the productivity in the final good sector will be relatively lower in the tax-economy, because firms can use a smaller array of intermediate goods. The welfare calculation suggests that the transitional effects associated with a lower entry rate tend to be weaker than the long run effect due to the acceleration of vertical innovation: Overall welfare goes up. When R&D subsidies are introduced on the top of corporate taxes, clearly welfare tends to be greater (6.3).

7 Conclusion

The European economies are thought of being below their potential. Clearly they have been running at a slower pace than what has been observed in the decades after WWII. There is ample room for debating the reasons. Some have attributed the current disappointment simply to unreasonable high expectations fueled by the belief that the new information and communication technologies could have a long-lasting effect comparable to the dissemination of electricity or steam engines (Gordon). Others have pointed out that growth may have slowed down in advance economy because of the changed complementarity between technology and human capital (Goldin and Katz). Scholars more attentive to the level of income as a determinant of the firm's investment are more prone to attribute the slowdown to a mix of restrictive fiscal and monetary policy. In reviewing these points of views we have pointed out the objective difficulty in asserting conceptually how far away an economy is from its potential level of production, and the econometric challenges to estimate such a gap.

Our review of endogenous growth models poses the basis for studying the most promising channels through which policy can affect growth. First, most models of technological progress assume some monopolistic competition and some sorts of knowledge externalities. This means that there are two types of inefficiencies that in principle can be targeted by public policy: the static inefficiency of a monopolistic price; the sub-optimal investment in goods that generate knowledge. Second, growth is driven by a combination of investments by new entrants and by incumbents. An

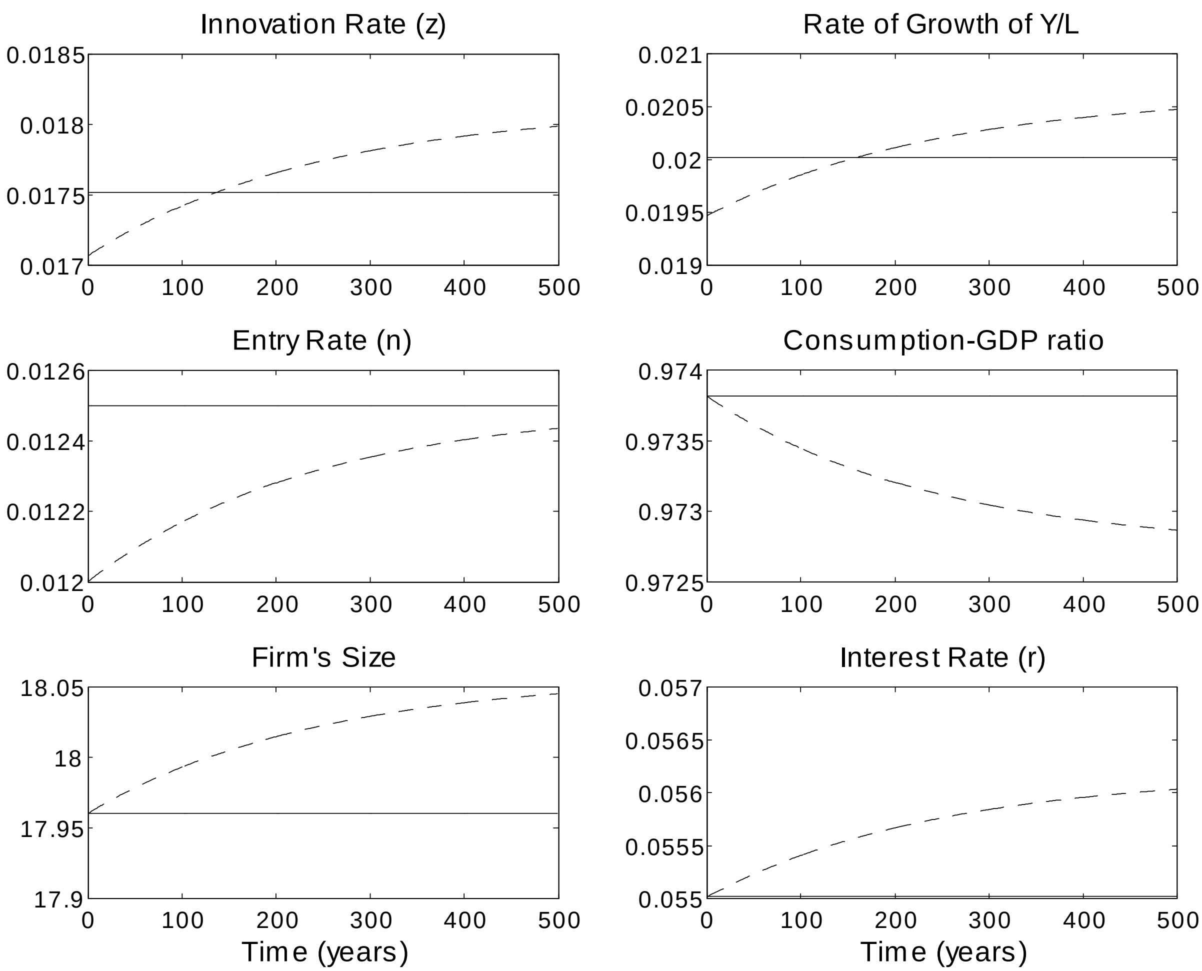

Figure 3: Impulse Responses to Financial Income Tax

Note: The figures show the consequences of the introduction of a 1% tax on financial income ($\tau_a = 0.01$).

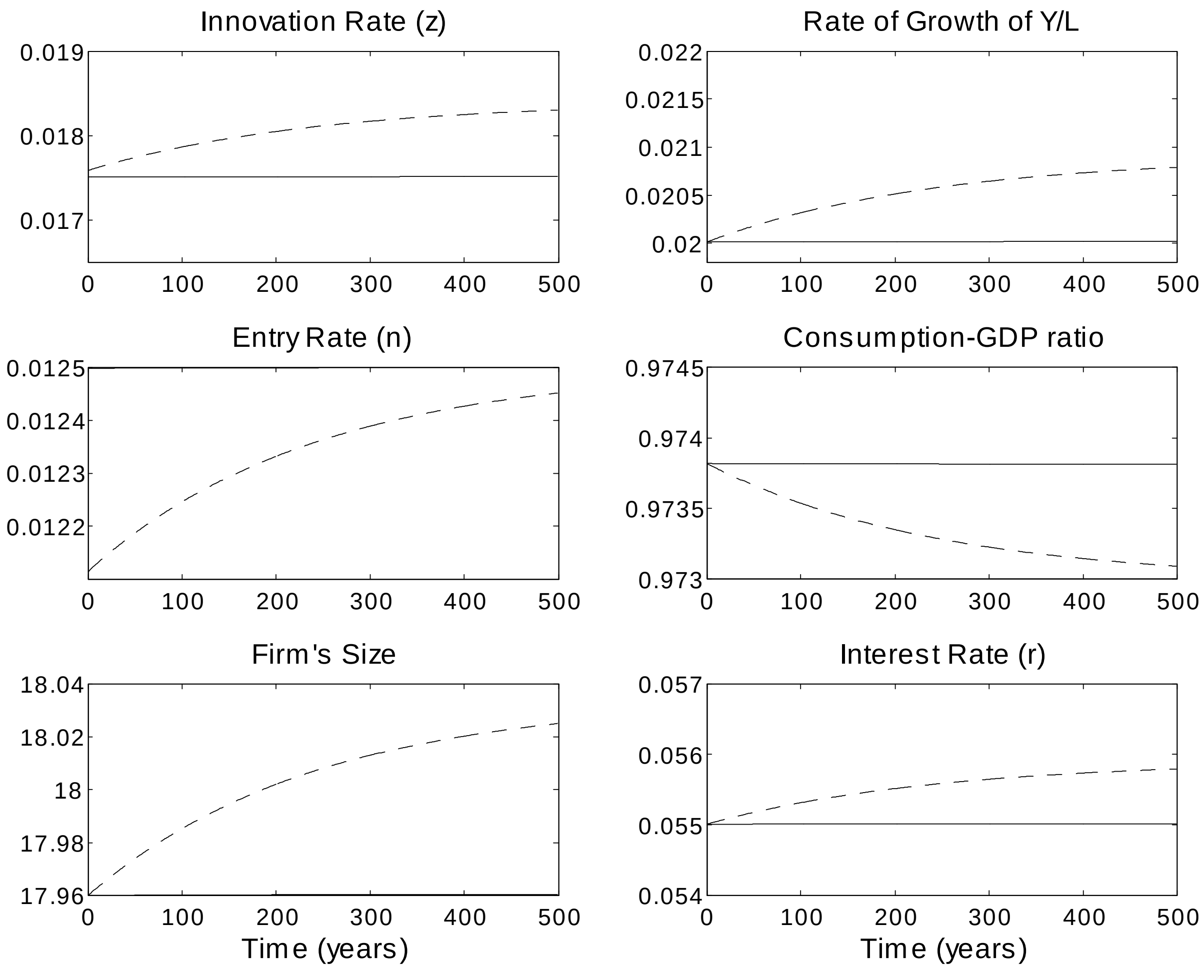

Figure 4: Impulse Responses to Corporate Tax

Note: The plots show the impulse responses to the introduction of a 1% tax rate on corporate profits ($\tau_{\Pi} = 0.01$).

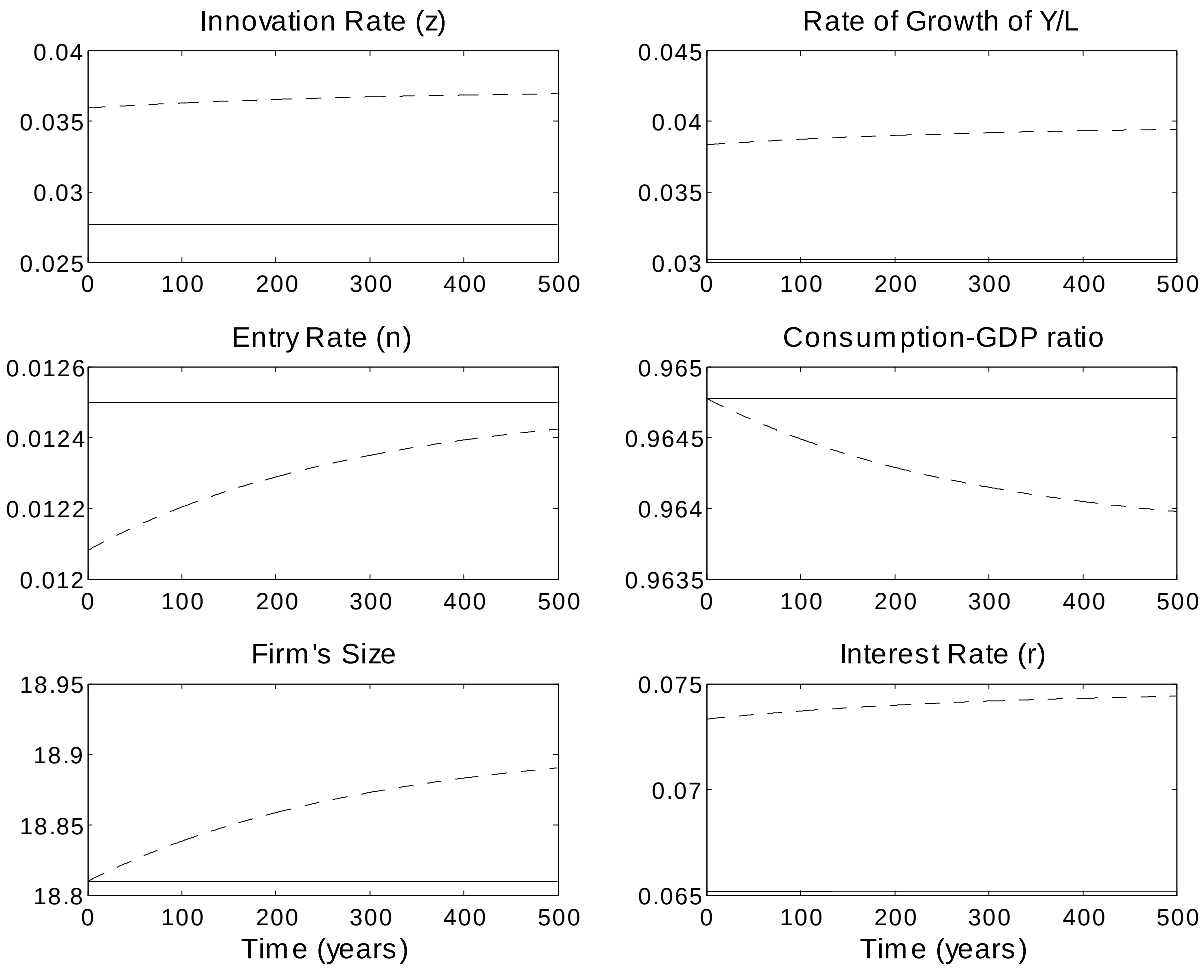

Figure 5: Impulse Responses to RD Subsidy

Note: In an economy with a 10% corporate tax rate a 100% tax deduction on R&D spending is introduced ($d = 2$)..The dashed lines are the impulses responses.

active industrial policy that rises the barrier to entry would favor growth-process driven by existing firms, and would tend to create larger firms. Whether such an industrial policy would be welfare reducing or augmenting is ambiguous. The conclusion depends mostly on the hardly observable fact of whether it is more likely that incumbents are more or less likely than new firms to generate knowledge that spills over in the industry.

As a way to highlight the difference between short and long run growth effects of fiscal policy measures we proposed a few illustrations of the propagation mechanisms of shocks to capital and corporate tax within the framework of a Schumpeterian growth model. A key feature of this class of models is that growth can be driven by the entry of new firms, and by the accumulation of knowledge of existing firms. The examples have shown some important asymmetries between the short and the long run responses to a given policy. In the short run both the entry rate and the innovation rate are affected. For instance the introduction of a tax on capital income lowers the entry rate, and therefore gives more market share to existing firms, but it also induces them to slowdown their investments. As the economy approaches its long run equilibrium, however, the innovation rate, driven by incumbent firms, goes well beyond the pre-tax economy, whereas the entry rate converges to the same level. Therefore the sign of the welfare change can be positive or negative, depending on the length of the transition.

We think that this paper has identified fruitful directions for future research on the links between potential growth and output gap. It calls for a need to develop a framework in which public and private investments are linked to human capital formation and the acceptance of new technologies. A problem with models of potential growth is that they tend to take for granted that new knowledge and new technologies are immediately available to the public. Therefore the weakness of an economy tends to be associated with lack of (past) resources allocated to investment in schools and in R&D. A second problem is that they have little to say about the role of monetary policy, unless it is a source of substantial macroeconomic instability, and on the welfare consequences of following rules of thumb in fiscal policy, as it is now done in the EU.

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